APS A subsidiary of Pinnacle West Capital Corporation

Proposal for Information Collection

Arizona Public Service
Four Corners Generating Station
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Submitted In Partial Compliance with
316(b) Phase II Regulatory Requirements

April 2005

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EPRI SOLUTIONS

List of Acronyms

APS	Arizona Public Service
BTA	Best Technology Available
CDS	Comprehensive Demonstration Study
EPA	Environmental Protection Agency
IM	Impingement Mortality
IM&E	Impingement Mortality and Entrainment
NPDES	National Pollutant Discharge Elimination System
PIC	Proposal for Information Collection
PSIG	Pounds Per Square Inch Gauge
TIOP	Technology Installation and Operation Plan

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EXECUTIVE SUMMARY

This Proposal for Information Collection (PIC) is submitted in compliance with final 316(b) Phase II Regulations for existing electric generating stations published in the federal register on July 9, 2004. Because the facility is located on a freshwater reservoir it will only be subject to the impingement mortality (IM) performance standard which requires an 80 to 95% reduction in impingement mortality. The PIC provides EPA Region IX with APS's plans for conducting necessary biological studies, analyzing existing biological information and evaluating alternative fish protection technologies and use of the Rule's compliance alternatives. It is APS's intention to evaluate a wide range of options and alternatives. Currently APS has identified several alternatives that it considers to be preferred options due to their cost effectiveness. These preferred options include potential use of restoration under compliance alternative 2 and/or 3, use of a barrier net or fixed panel screens to reduce the maximum design intake velocity under compliance alternative 1, and use of site-specific standards (either the cost-cost or cost-benefit test) under compliance alternative 5. The basis for these preferred alternatives are discussed in Section 3 of the PIC. APS is also planning to initiate a one year impingement sampling study in 2005.

Based on the results of a one year impingement study proposed to begin in 2005, a quantitative assessment will be conducted to select a compliance alternative or set of alternatives for use at Four Corners. Additional studies and evaluations may be conducted as necessary and appropriate to gather the necessary information to prepare the Comprehensive Demonstration Study (CDS) for submittal to EPA Region IX on or before January 7, 2008. The Rule encourages the NPDES permitting authority to review and provide comments on the PIC within 60 days. While EPA may not be able to comment on all aspects of the PIC in this time frame, APS is particularly interested in feedback on the proposed IM study plan presented in Attachment B. The results of the study plan will form the basis of decision making for selection of compliance alternatives and the CDS documents that will be submitted.

EPRI SOLUTIONS

1. INTRODUCTION

EPA signed into regulation new requirements for existing electric power generating facilities for compliance with Section 316(b) of the Clean Water Act on July 9, 2004. These regulations became effective on September 7, 2004 and are based on numeric performance standards[1]. The Rule has established that all facilities must meet performance standards of reducing impingement mortality by 80-95% from a calculation baseline, and only a selection of facilities must reduce entrainment by 60-90% from a calculation baseline.

The Rule at 125.94(a)(1-5) provides facilities with five compliance alternatives as follows:

1. A facility can demonstrate it has or will reduce cooling water flow commensurate with wet closed cycle cooling and be determined to be in compliance with all applicable performance standards. A facility can also demonstrate it has or will reduce the maximum design through-screen velocity to less than 0.5 ft/s in which case it is deemed in compliance with the impingement mortality (IM) performance standard (the entrainment standard, if applicable still applies).
2. A facility can demonstrate that it has technologies and/or operational measures and/or restoration measures in place that will meet the applicable performance standards.
3. A facility can propose to install new technologies and/or operational measures and/or restoration measures to meet applicable performance standards.
4. A facility can propose to install, operate and maintain an approved design and construction technology.
5. A facility can request a site-specific determination of Best Technology Available (BTA) by demonstrating that either the cost of installing technologies and/or operational measures and/or restoration measures are significantly greater than the cost for the facility listed in Appendix A of the rule or that the cost is significantly greater than the benefits of complying with the applicable performance standards.

All facilities that use compliance alternatives 2, 3, and 4 are required to demonstrate a minimum reduction in impingement mortality of 80% (125.94(b)(1)). Facilities with a capacity factor that is greater than 15% that are located on oceans, estuaries or the Great Lakes or on rivers and have a design intake flow that exceeds more than 5% of the mean annual flow must also reduce entrainment by a minimum of 60% (125.94(b)(2)).

The Rule further requires that facilities using compliance alternatives 2, 3, and 5 prepare a Comprehensive Demonstration Study (CDS) as described at 125.95(b) of the Rule. The CDS

[1] Performance standards are found at 125.94(b) of the Federal Registrar.

includes seven components necessary to support the compliance alternative or alternatives selected. Facilities using compliance alternative 1 are not required to submit a CDS and those using compliance alternative 4 are only required to submit the Technology Installation and Operation Plan (TIOP) and Verification Monitoring Plan. All facilities that use compliance alternatives 2, 3 and 5 are required to prepare and submit a "Proposal for Information Collection", the first component of the CDS. The Rule at 125.95(b)(1) requires that the PIC include:

1. *A description of the proposed and/or implemented technologies, operational measures, and/or restoration measures to be evaluated in the Study.*
2. *A list and description of any historical studies characterizing impingement mortality and entrainment and/or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to this proposed Study. If you propose to use existing data, you must demonstrate to the extent to which the data are representative of current conditions and that the data were collected using appropriate quality assurance/quality control procedures.*
3. *A summary of any past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to this Study and a copy of written comments received as a result of each consultation.*
4. *A sampling plan for any new studies you plan to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of impingement mortality and entrainment at your site. The sampling plan must document all methods and quality assurance/quality control procedures for sampling and data analysis. The sampling and data analysis methods you propose must be appropriate for a quantitative survey and include consideration of the methods used in other studies performed in the source waterbody. The sampling plan must include a description of the study area (including the area of influence of the cooling water intake structure(s)), and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish).*

The preamble to the Rule on Federal Register Page 41635 states that the proposal should provide other information, where available, to the NPDES permitting authority on plans for preparing the CDS such as how the facility plans to conduct a Benefits Valuation Study; or gather additional data to support development of a Restoration Plan.

An important feature of the Rule is use of the calculation baseline. The calculation baseline is defined in the rule as follows:

Calculation baseline means an estimate of impingement mortality and entrainment that would occur at your site assuming that: the cooling water system has been designed as a once-through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh traveling screen is oriented parallel to, the shoreline near the surface of the source waterbody; and the baseline practices, procedures, and structural configuration are those that your facility would maintain in the absence of any structural or operational controls, *including flow or velocity reductions, implemented in whole or in part for the purposes of reducing impingement mortality and entrainment. You may also choose to use the current level of impingement mortality and entrainment as the calculation baseline. The calculation baseline may be estimated using: historical impingement mortality and entrainment data from our facility or another facility with comparable design, operational, and environmental conditions; current biological data collected in the waterbody in the vicinity of your cooling water intake structure; or current impingement mortality and entrainment data collected at your facility. You may request that the calculation baseline be modified to be based on a location of the opening of the cooling water intake structure at a depth other than at or near the surface if you can demonstrate to the Director that the other depth would correspond to a higher baseline level of impingement mortality and/or entrainment.*

This definition allows existing facilities to take credit for facility features that deviate from the calculation baseline and provide the benefit of fish protection or credit for previously implemented restoration measures. Facilities can also simply develop the baseline by documenting the baseline using the "as built" approach.

2. Description of Facility

APS's Four Corners Generating Station (Four Corners) is located on Morgan Lake, seven miles southwest of Fruitland, New Mexico. Four Corners is a point source facility and withdraws more than 50 MGD from a water of the U.S., its primary activity is generation and transmission of electric power and it uses at least 25% of withdrawn water for cooling. Therefore, it meets the definition of a Phase II facility.

Four Corners has five once-through cooling Units. Units 1 & 2 are each rated for 170 MW, Unit 3 is rated for 220 MW, and Units 4 & 5 are each rated at 740 MW each. From 2000–2003, the average capacity factor for the facility was 83%, making it a base loaded facility.

Condenser cooling and service water is withdrawn under a skimmer wall located in the south-western corner of the lake. The skimmer wall is positioned at the mouth of the intake canal and extends down to El. 5,285.0 ft, 42.5 ft below the high water elevation (EL. 5,327.5 ft) and is 10 ft above the invert of the intake canal based on the original design. The facility uses two screenhouses located downstream of the skimmer wall. The screenhouse for Units 1–3 is located about 450 ft downstream of the skimmer wall and the Units 4 & 5 screenhouse is located at the end of an intake canal west of the Units 1–3 screenhouses.

The screenhouse for Units 1–3 has seven bays, each with a curtain wall and traveling water screen. All screens are 27 ft high and have 0.25 in. rectangular mesh. This mesh provides a 64% open area. The traveling screens are rotated daily to remove debris. During operation the screens are rotated less than one revolution. The screens also rotate automatically when there are high differential pressures across the screen. Fish and debris on the screens are removed by a high-pressure (80 psi) front spray wash during cleaning. The wash water and debris from Units 1-3 discharges into the intake canal leading to Units 4 & 5.

Downstream of the traveling water screens are six circulating water pumps, two pumps per unit. The pumps for units 1 & 2 are each rated for 50,000 gpm (72MGD). Unit 3 has larger pumps each rated for 64,250 gpm (92.52MGD). The total circulating water flow is about 328,500 gpm (473.04MGD).

The screenhouse for Units 4 & 5 is located at the end of a long intake canal, which was added to the western bank of the Unit 1–3 intake canal. It has four bays that are 15.2 ft wide and have 14 ft wide traveling water screens. These screens have 5/8 in. square mesh and have been modified with serrated plates that bisect the screen baskets horizontally. Fish and debris washed off the screens are deposited in a trash basket for disposal. The screens are typically only cleaned when there is a high differential pressure across the screens. Unit 4 pumps are rated for a flow of

229,000 gpm (329.76MGD) and Unit 5 pumps are rated at 215,000gpm (309.6MGD). In addition, each intake bay has either a screenwash or an ash sluice pump. Unit 5 (north) and Unit 4 (south) have screenwash pumps, these pumps are rated for 3,050 gpm (4.392MGD). Ash sluice pumps rated for 2,200 gpm (3.168MGD) are located in the Unit 5 (south) and the Unit 4 (north) intake bays. With all pumps operating, this intake withdraws 898,500 gpm (1293.84MGD) based on design values.

Cooling water for all five units is returned to Morgan Lake via a discharge canal to the east extremity of the lake. The water then flows back to the center of the lake and is recirculated to the intake canal.

Morgan Lake is a man-made reservoir that was created in 1961 to provide cooling water for Four Corners. The water rights for the lake are currently owned by BHP, a mining company. The lake is maintained between high and low water levels of El. 5,327.5 ft and El. 5,325.5ft, respectively, based on operational records. Normal water level in the lake is high water. The lake has an approximate surface area of 1,200 acres, and contains about 39,000 acre ft of water. The dominant current in the lake is caused by the recirculating cooling water system used by Four Corners. Make-up water for the lake is provided by a river water pumphouse. This pumphouse pumps about 16,667 gpm (24MGD) from the San Juan River.

To calculate the velocities in the intake canal, it was assumed that minimal siltation has occurred and that the intake canal bottom is at El. 5,275.0 ft under the skimmer wall and at El. 5,306.0 ft in the intake canal. The approach velocities at the traveling screens for Units 1 & 2 are 0.9 fps, 1.0 fps for Unit 3 and 2.4 fps for Units 4 & 5.

3. Compliance Alternatives To Be Evaluated

APS plans to evaluate potential use of each of the Rule's compliance alternatives before making a final decision on which alternative or combination of alternatives to use as the basis for the Comprehensive Demonstration Study (CDS). In this Section each of the Rule's compliance options and alternatives to be evaluated for use at the Four Corners Generating Station are discussed. APS plans to consider use of each of the Rule's five compliance alternatives, however based on currently available information some alternatives appear to be more cost effective for meeting the IM standard than others. The PIC specifies that a description of the technologies, operational measures and restoration measures to be evaluated must be provided and that is the purpose of this section of the PIC. The Rule's compliance options and alternatives that will be evaluated are as follows:

Use of Restoration Under Compliance Alternatives 2 and 3

Morgan Lake was constructed in the desert terrain for the purpose of providing cooling water for the Four Corners Generating Station. The surface area of approximately 1,200 acres and the approximately 39,000 acre ft of water contained were scaled for the purpose to ensure adequate condenser cooling. Four Corners subsequently agreed to allow the Navajo Tribe to make use of the aquatic habitat provided through construction of the Lake for the purpose of creating a recreational fishery. While some incidental introduction of fish probably occurred when water was pumped from the San Juan River to fill Morgan Lake, the current recreational fishery is largely the result of Tribal fishery management efforts to introduce species for recreational harvest. Currently the species of highest interest is largemouth bass. The Rule specifically allows credit for existing restoration projects under compliance alternative 2 as long as the restoration measures currently in place are not the result of mitigation required for compliance with Section 404 or some regulatory requirement other than 316(b). Restoration measures were implemented in many cases under existing State 316(b) regulatory programs as a means of offsetting impingement and/or entrainment losses. Four Corners' creation of aquatic habitat that supports the current Morgan Lake recreational fishery is no different that other such restoration programs. APS plans to pursue quantification of the aquatic habitat created to determine if it is adequate to support a level of fish production adequate to offset 80% to 95% of the annual impingement mortality necessary to comply with the IM performance standard. If there is not adequate habitat to meet the standard APS plans to evaluate use of additional restoration measures to achieve the level necessary to comply under compliance alternative 3 (See Attachment A). APS, as part of the requirement for use of restoration, plans to fully evaluate available technologies and/or operational measures to demonstrate that existing and any necessary supplemental restoration is more feasible, cost effective or environmentally desirable than meeting performance standards through the use of technologies and/or operational measures (see below in this Section). Also, as a prerequisite to determining if the amount of aquatic habitat has been created to provide a benefit equivalent to an 80% to 95% impingement mortality reduction, the results of a proposed impingement mortality characterization study will be needed. The PIC discusses plans to acquire this information in Section 4 and Attachment B. APS is also aware that use of restoration is currently the subject of Phase II Rule litigation. The Second Circuit ruled restoration could not be used in the 316(b) Phase I Rule. Based on the Courts decision, EPA added significant text to the final Phase II Rule to support the legal basis for use of this option. APS, based on the time for the Court to reach a decision on the Phase I Rule believes that the Phase II Rule decision should be rendered at approximately the same time that results of the proposed impingement sampling data will become available in the spring of 2006. When the impingement data necessary for restoration scaling and results of the litigation are available, APS can quantitatively determine if adequate restoration has been created or if supplemental restoration would be necessary to meet the IM reduction standard.

Use of Fish Protection Technologies and/or Operational Measures under Compliance Alternatives 1, 3 and 4

Should use of restoration measures not be available as a result of Rule litigation APS plans to evaluate use of fish protection technologies. APS has already engaged Alden Research Laboratory Inc to conduct a very preliminary evaluation of available fish protection technologies and operational measures. Based on this analysis, APS plans to evaluate use of the following fish protection technologies and operational measures.

Reduce Intake Velocities to Not Exceed 0.5 ft/sec under Compliance Alternative 1

Reducing the maximum through screen design velocity to not exceed 0.5 fps would automatically comply with the impingement mortality standard and avoid the need for preparation of the Comprehensive Demonstration Study (CDS) and impingement mortality reduction performance monitoring. This velocity could be achieved by increasing the current intake screen surface area. For example, APS can evaluate installing fixed panel screens in front of the existing skimmer wall in a manner to increase surface area or install a barrier net year round.

Expanding the open area under the skimmer wall and installing fixed panel screens in its place could be a means of reducing the average through-screen velocity of 0.5 ft/sec or less. This velocity would meet the criteria for EPA Compliance Alternative 1 required to meet the IM standard. To achieve this velocity of 0.5 ft/sec the open area would need to be 35 ft high, which would require the skimmer wall to be removed up to El. 5,310.5 ft, 10 ft below the water surface. Withdrawing water from the closer to the surface may cause the recirculation of warmer water into the intake, and lower unit efficiencies which could significantly increase the cost of using this option. The screens could be made out of wedge wire with a 3/8" slot size. The screens could be mounted to the existing skimmer wall structure. A trash rack may need to be located upstream of the fixed panel screens to minimize damage from large debris.

The screens would be cleaned with a mechanized rake or lifted with a hoist for periodic cleaning. Head loss across the screens would be minimal (<0.1 ft).

A second option to be evaluated will be design of a barrier net can that can be maintained in place year round. The design would have a mesh size that would not exceed 3/8 in and ensure that a continuous seal is maintained year round. Use of a barrier net is also discussed as an alternative under use of compliance alternative 3 below. For use as a compliance alternative 1 option, a double barrier net system would be necessary to ensure that a continuous barrier remained in place year round when one net was removed for cleaning or maintenance.

Use of Fish Protection Technologies and/or Operational Measures under Compliance Alternative 3:

Several technologies have been identified that have the potential for use at Four Corners that will be evaluated and include:

<u>Coarse Mesh Ristroph Traveling Water Screens</u>

The existing traveling water screens for all five units, 10 screens total, could be replaced with a new state-of-the-art coarse mesh Ristroph screens to reduce the mortality of impinged fish. These screens are typically designed to have a screen approach velocity of 1.0 ft/sec at plant design flow, to assure impingement survival. The existing velocities within the Units 1–3 screenhouse are consistent with the screen design velocity and therefore no expansion of the intake would be necessary. The velocities at the screenhouse for Units 4 & 5 are more than twice the recommended velocity. To lower the velocity, additional screenbays could be added to the intake. However, because of space constraints, this may not be a feasible option. Alternatively, flow reduction could be used to lower velocity without additional civil/structural modifications to the intake. Flow reductions, however, could result in substantial lost generation.

The ability of coarse mesh Ristroph screens to effectively reduce impingement mortality is highly species specific. This technology requires the collection of fish on the screens, transfer to a transport system followed by transport back to the source waterbody. Many fish species are highly tolerant of the required handling and transport while others are not. Results of the proposed impingement sampling study will be necessary to document the species in need of protection to fully evaluate the potential of this technology to meet the performance standard. Site specific pilot studies would be necessary to verify site specific survival rates for impinged species. This will be especially important since velocities of Units 4 and 5 are greater than the 1.0 design and space constraints limit APS's ability to add more screens.

New Ristroph screens in both screenhouses would be rotated continuously to minimize impingement times, thereby, improving survival. New fish return and debris troughs would be added to each screenhouse which would discharge back to the lake.

Modular Inclined Screens

An MIS module consists of a square entrance, upstream and downstream dewatering gates, an inclined screen set at a shallow angle (10–20°) to the flow, and a bypass for directing diverted fish to a transport pipe. The module is completely enclosed and is designed to operate at relatively high water velocities ranging from 2 to 10 ft/sec, depending on species and life stages to be protected. MIS modules may be a good retrofit option for Units 4 & 5 due to the high velocities in the intake canal and traveling water screens.

Units 4 & 5 would require five modules, each with 10 ft square openings installed at the mouth of the Units 4 & 5 intake canal. This location was selected to minimize dredging and the length of the fish return pipe.

The average approach velocity to each screen would be 5.8 ft/sec at the design intake flow of 2,551 cfs. The screen material would be wedge wire, with the screen bars arranged parallel to the flow direction. The screen panel would have a uniform porosity of 50% with a 2 mm clear bar spacing along their entire length. The screen would be rotated to backwash debris from the screen face. The fish bypass entrances (3 ft square) would be located at the downstream end of the screens and would direct fish to a 6 ft diameter pipe that would be connected to fish pumps. The fish pumps would pump bypass flow into a drop basin to a fish return pipe, exiting back to the lake. It is not expected that large debris will be a problem downstream of the skimmer wall; therefore, the MIS modules will not need trash racks.

Cleaning of the screens would be necessary to minimize adverse impacts on facility operation resulting from debris accumulation (additional head losses) and to maintain the fish diversion efficiency of the inclined screens. The traveling water screens would be required to operate during a backwash to collect debris.

MIS installation would be expected to significantly reduce IM. However, pilot tests with RS may be necessary to determine effectiveness in meeting the performance standards.

Barrier Net

A 3/8 in. (or similarly sized) mesh barrier net designed for a 0.25 ft/sec approach velocity could be installed upstream of the skimmer wall in Morgan Lake. Assuming the water depth in front of the skimmer wall is about 50 ft deep, the net would need to be about 220 ft long and 55 ft high. The net would be placed in an arching configuration about 100 ft upstream from the skimmer wall. This configuration should allow for a relatively even flow through the entire net. The net would be supported by bottom anchors and top floatation. Top and bottom anchor lines would run between the anchors and attach to net panels where they connect. A breakaway panel would be installed in the middle of the net to minimize damage to the nets and support system if severe debris loading occurred. The existing traveling screens would need to remain in place and operational with this alternative to remove any debris that is behind the net or in case the net fails.

Replacement of the net may be required as frequently as every year. Since the rate of debris loading and biofouling of a barrier net in Morgan Lake is not known and could not be determined until actual installation, it is assumed at this point that the net would have to be removed about 42 times a year for cleaning, (every week throughout the year with the exception of winter when the net would only need removal biweekly). Two nets would be needed to allow for this cleaning schedule. Replacement would take approximately 1 day for divers to remove the dirty net and install a clean one.

Barrier nets have been proven to reduce IM by reducing total impingement; therefore, a pilot study would not be required. Optimizing the mesh size, deployment period, and cleaning schedule could be determined after installation of the net, with an adaptive management plan based on the results of in situ testing.

APS plans to conduct a more detailed analysis of the feasibility, effectiveness and cost of the alternatives described above in 2005. When results of the impingement sampling are available in 2006, should APS decide to comply using one or a combination of technology or operational measures, they may propose pilot studies in 2006/2007.

Use of a Pre-approved Technology under Compliance Alternative 4

Currently use of wedge wire screens in rivers that meet certain criteria is the only named pre-approved technology. However the Rule provides a process that allows additional technologies to become listed pre-approved technologies. New technologies can be so designated by providing information to demonstrate that if installed in the facilities waterbody type, the technology would have little trouble meeting performance standard for which it was pre-approved.

In general as a result of the final Rule there is significant research in the market place to develop new, more cost-effective fish protection options. APS plans to monitor the development and testing of new technologies for potential use under this compliance alternative. Should a candidate technology be identified, APS will notify EPA Region IX and request to amend the PIC to identify any additional technologies to be evaluated for use at Four Corners.

Use of Site Specific Standards under Compliance Alternative 5

APS plans to evaluate potential use of both the cost-cost and cost-benefit tests under compliance alternative 5. Use of these alternatives are provided to allow Phase II facilities to avoid compliance costs that would be considered either significantly greater that the costs estimated by EPA for facilities or the economic value of the environmental benefits that would be achieved through meeting applicable performance standards.

In developing the National Cost of implementing the Rule EPA considered the cost for each Phase II facility to comply. The cost for Four Corners is found in Appendixes A and B of the Rule. Appendix B can be used to identify the facility number which in the case of Four Corners is AUTO453. Using the ID number the Rule's estimated cost for Four Corners is listed as n/a. The Rule's preamble states that for facilities assigned n/a, $0 should be the cost used for the cost-cost test. However, APS believes the listing as n/a was due to an error in the response to the original Short Industry Technical Questionnaire and has requested re-evaluation of costs for the facility in a letter to the EPA dated January 19, 2005. APS plans to evaluate use of the cost-cost test based on the revised Appendix A estimate to determine if the cost of the technologies to be evaluated is significantly different.

The economic value of the environmental benefit of meeting the performance standard will also be evaluated. This analysis cannot be conducted until the proposed impingement study is completed, since that data will serve as the basis for the environmental benefit quantification. The proposed method for conducting the environmental benefit valuation is provided in Attachment C. This is the approach planned for the environmental benefit evaluation that will be conducted in 2006, based on results of the 2005 impingement study and the more detailed engineering assessment of alternative fish protection measures also planned for 2005.

4. Biological Studies

The Rule requires that a summary of historical IM studies and/or physical and biological studies conducted in the vicinity of the cooling water intake structure be provided as well as study plans for any new IM studies to be conducted. This information is summarized in Attachment B. No impingement studies were previously conducted at the Four Corners. One year of impingement sampling is proposed to begin in 2005.

5. SUMMARY OF CONSULTATIONS WITH AGENCIES

The Rule requires that "a summary of any past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to the CDS and a copy of written comments received as a result of such consultations be provided".

There has been only one consultation with a Federal, State, or Tribal fish and wildlife agency related to 316(b). On January 20, 2005 APS conducted a meeting with the Navajo Nation Department of Fish and Wildlife (NNFW) to discuss 316(b) and more specifically, plans for conducting impingement sampling on Morgan Lake. NNFW manages Morgan Lake as a recreational fishery for largemouth bass. They also identified catfish and green sunfish as important species within the lake management plan. The green sunfish was selected due to its importance as the preferred forage base to support recreational species and largemouth bass and channel catfish because of their importance as recreational species. NNFW recommended that impingement studies be focused on the above three species of interest.

They identified several other species that were accidentally introduced into Morgan Lake and which have since become nuisance species. These species include Pacu (a South American exotic species), Plecostomus sp., gizzard shad, common carp, and mosquito fish. The presence of these species in Morgan Lake adds a risk to the management of important recreational species and may even pose a risk to threatened or endangered species in nearby waterbodies (i.e. the San Juan River) if these species were to be transported downstream of Morgan Lake. NNFW would prefer that these species be extirpated from the Lake as long as this could be accomplished without risk to the important species. A copy of the letter received from NNFW after the meeting is provided in Attachment D.

6. Schedule for Information Collection

The Rule allows facilities with NPDES permits that expire within four years of the date of publication of the Rule in the Federal Register (July 9, 2004), up to three years and six months to submit the CDS (125.95(2)(ii)). APS considers three and a half years to be a very short time frame to complete the required studies and believes that the full three years and 180 days will be required to complete the CDS for Four Corners. The Rule requires that this PIC be submitted to EPA Region IX prior to initiating new 316(b) studies. While the Rule allows facilities to initiate studies after submittal, APS is anxious to provide time for EPA Region IX to review and comment on the study plan. The Rule encourages that Region IX provide comments within 60 days to allow time to make any necessary modifications to our study plans.

In order to make final compliance alternative determinations for Four Corners it will be necessary to evaluate the results of the one year impingement mortality data. It is anticipated that after the conclusion of the one year of proposed data collection it is likely to take up to 3 months to complete input of results into a database, QC the database and analyze the data for use in compliance decision making. This should allow APS to quantitatively evaluate the various compliance alternatives discussed in Section 3 of the PIC. It is anticipated that by this time frame the results of the Phase II litigation should be available for making compliance decisions on compliance alternatives and options. Should restoration be available, APS can evaluate the IM characterization study results to quantitatively assess use of restoration under compliance alternatives 2 and 3. This information can be considered in context with the results of the detailed evaluation of alternative fish protection technologies. The IM data analysis will also allow quantification of the benefits in order to evaluate potential use of the cost-benefit test based on technology and operational cost estimates developed in 2005. Finally, these study results can also be used to assess the potential effects of feasibility, efficacy and cost of the alternative technologies and/or operational measures being evaluated.

APS then plans to use the remainder of 2006 and the early part of 2007 to engage in the necessary work to develop the information to support the CDS based on the compliance alternative(s) selected. If restoration is used, a final decision on the nature of the restoration project will be made and work on the Restoration Plan will be initiated. If use of technologies and/or operational measures is selected for compliance, appropriate pilot studies or testing will be conducted to collect information necessary to support the Design and Construction Technology Plan, Technology Installation and Operation Plan and the Verification Monitoring Plan. If use of site specific standards is used for compliance, work will be initiated to prepare the necessary documents to support this alternative including the Comprehensive Cost Evaluation Study, Benefits Valuation (if the Cost-Benefit Test is used) and Site-Specific Technology Plan.

The Rule recognizes that the CDS studies are an iterative process[2] and allows facilities to modify the PIC based on new information. APS may request that the PIC be amended, as necessary, based on new information relative to technologies and operational measures, use of restoration measures, Phase II Rule litigation or subsequent Agency guidance.

[2] See Rule preamble first column pg 41235 of Federal Register/Vol. 69, No. 131/Fri 7/9/04.

EPRI SOLUTIONS

Appendix

A. RESTORATION MEASURES TO BE EVALUATED

Restoration Measures to be Evaluated for 316(b) Compliance at Four Corners Steam Electric Generating Station

The final Phase II Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards or in establishing best technology available (BTA) on a site-specific basis. Specifically, EPA's final Phase II Rule states the following requirement relative to the use of the restoration approach:

> *Facilities that propose to use restoration measures must demonstrate to the permitting authority that they evaluated the use of design and construction technologies and operational measures and determined that the use of restoration measures is appropriate because meeting the applicable performance standards or requirements through the use of other technologies is less feasible, less cost-effective, or [emphasis added] less environmentally desirable than meeting the standards in whole or in part through the use of restoration measures.*

Types of Restoration Applicable to §316(b)

The Rule does not specify the types of restoration measures that can be used. This lack of specification provides flexibility in developing/proposing a restoration approach. Restoration measures that have been used at other power stations to meet §316(b) requirements include:

- Wetland restoration (e.g., Public Service Electric & Gas (PSEG) Delaware Bay wetland restoration program for the Salem Generating Station)(Weinstein et al. 2001).
- Fish stocking (e.g., Mirant's fish hatchery at the Chalk Point Station (Bailey et al. 2000); Exelon's (formally Commonwealth Edison) walleye hatchery at Quad Cities Station on upper Mississippi River (LaJeone and Monzingo 2000); and Southern California Edison's white sea bass hatchery).
- Submerged aquatic vegetation (SAV) restoration (e.g., Southern California Edison's kelp restoration for the San Onofre Nuclear Generating Station)(Deysher et al. 2002).
- Provision of fish passage (e.g., fish ladders or dam removal) at non-hydropower projects (e.g., PSEG fish ladders in Delaware Bay tributaries for the Salem Generating Station).
- Contribution to, or maintenance of, a restoration fund related impacts associated with the re-powering of the Moss Landing Station on Elkhorn Slough near Monterrey Bay, California.
- Water quality improvements (e.g., riparian area protection or implementation of non-point source best management practices) that minimize sediment/pollutant runoff thereby resulting in fishery habitat improvements, and practices that increase dissolved oxygen content in waterbodies thereby increasing available habitat for fish spawning and survival. While this

approach is plausible, there are no known existing examples of such a 316(a&b) restoration project.

Potential Restoration Measures to be Evaluated for APS's Four Corners Steam Electric Generating Station

APS plans to consult and coordinate with the Navajo Nation Department of Fish and Wildlife to determine restoration efforts that would be of value to the recreational management and interests of the Department for Morgan Lake as a fishery.

APS also plans to consider the example restoration projects discussed in this section to attain the impingement mortality reduction performance standard or as part of a site-specific standard developed by the permit director. These projects are listed because of their (1) 316(b) application history by other power companies, (2) known interest to fish and wildlife agencies in the Four Corners based on an internet review of state programs, and (3) because design and implementation information is readily available.

- Fish stocking– this involves the direct supplementation (stocking) of a fish species of concern to aid restoration efforts for that species. It is anticipated there are potential species of interest for restoration in Morgan Lake.

- Habitat Protection Program Participation – The importance of wetlands as aquatic habitat for fish and invertebrates and as habitat for wildlife is generally known. Loss of wetland habitat is well documented and wetland restoration, or habitat restoration in general, is increasingly becoming popular across the U.S.. There is a growing case history with use of habitat restoration as a §316(b) mitigation approach.

- Alternative restoration measures – Other potential approaches include nonpoint source pollutant runoff abatement and other water quality improvement programs. Non-point source runoff has been identified as a significant issue and could be an area of restoration interest. While these types of efforts focus on water quality improvements, the long-term benefit is improved fish and shellfish habitat. Such efforts would have to demonstrate a clear linkage between the two as compensation for impingement mortality losses at APS's Four Corners.

B. PROPOSED NEW STUDY DESIGN

See following pages.

SAMPLING PLAN FOR THE IMPINGEMENT MORTALITY CHARACTERIZATION STUDY AT THE FOUR CORNERS GENERATING STATION

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April 2005

SAMPLING PLAN SUMMARY

An impingement sampling plan is proposed for the Four Corners Generating Station, located on Morgan Lake in Fruitland, New Mexico. The station is subject to the Clean Water Act §316(b) Phase II Rule for its NPDES permit, which requires that impingement mortality be reduced by 80 to 95 percent compared to a baseline level specifically determined for the facility. To comply with this Rule, the proposed sampling plan will provide information required to complete an Impingement Mortality Characterization Study for submission with its NPDES permit application. This sampling plan: 1) identifies existing data on the fish community in the vicinity of the cooling water intake structure and on impingement mortality occurring at the intake; 2) evaluates the sufficiency of these data to characterize current fish abundance, distribution, and impingement mortality at the intake; 3) makes a preliminary selection of Representative Species for detailed study; and 4) describes a work scope for impingement monitoring.

The Phase II Rule allows impingement mortality reduction to be quantified using Representative Species (RS), chosen to be surrogates for other species not selected for detailed study. RS typically are those most frequently observed in impingement collections, or those deemed to be most important because of their economic value (e.g., commercially or recreationally exploited species), value to the ecosystem (e.g., abundant prey species), or societal value (e.g., threatened or endangered species). Based on their current abundance in Morgan Lake, the preliminary selection of RS includes largemouth bass, channel catfish, and green sunfish.

Impingement mortality has never been monitored at the Four Corners Generating Station. Therefore, an impingement monitoring program is proposed to document diel, seasonal and annual impingement rates that reflect the current status of the fish community of Morgan Lake and the current intake operation. The table below summarizes the proposed features of the impingement mortality sampling program.

FOUR CORNERS GENERATING STATION SAMPLING PROGRAM SUMMARY

Program	Duration	Sampling Frequency	Data Collected
Impingement Monitoring	1 year	Biweekly for 12 months at each of the two sets of cooling water intake screens; samples over 24-hour period, with two 12-hour sampling intervals	Counts and biomass by species and life stage, length frequency, scale/otolith samples for RS, specimen condition, collection efficiency, ancillary environmental and operation data

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1. INTRODUCTION

ASA Analysis & Communication, Inc. has prepared this Impingement Mortality Sampling Plan as a component of the Proposal for Information Collection (PIC) for the Four Corners Generating Station (Four Corners). The PIC is being submitted to the U.S. Environmental Protection Agency (EPA) Region IX as required for an NPDES permit under the recently published §316(b) Phase II Rule of the Clean Water Act (CWA). The CWA §316(b) states that an applicant must demonstrate that the location, design, construction and capacity of its cooling water intake structure represents Best Technology Available (BTA) for minimizing adverse environmental impact. The primary impacts of concern under §316(b) are entrainment of smaller aquatic organisms into the cooling water system or impingement of larger organisms onto traveling screens in the cooling water intake. However, other non-impingement or entrainment impacts associated with various technologies or operating alternatives also may be considered in reaching a BTA decision.

The Phase II Rule applies to existing electric generating facilities (construction commenced prior to January 17, 2002) that have cooling water intake structures (CWIS) with a design capacity of 50 million gallons per day (MGD) or more, withdraw water from waters of the U.S., and use 25 percent or more of the water withdrawn for cooling purposes. Four Corners fits this definition for a Phase II facility. Compliance with the Phase II Rule is based on achieving performance standards for reduction of impingement mortality and entrainment set by the EPA on the basis of facility location. The Rule requires that impingement mortality be reduced by 80 to 95 percent compared to a baseline level (i.e., the calculation baseline) specifically determined for the facility. Since Four Corners is located on a reservoir, it is not subject to entrainment reduction performance standards.

The Rule requires development of a Comprehensive Demonstration Study (CDS), unless the applicant can demonstrate that their facility's CWIS flow is commensurate with a closed-cycle recirculating system or that its design intake velocity is 0.5ft/s or less. The PIC is a component of the CDS and includes a sampling plan for the proposed field studies necessary to supplement existing information about the source waterbody, its fish and shellfish community, and the current impingement mortality rate. If it is determined that existing information might not accurately represent current impingement mortality, the sampling plan will propose impingement sampling in support of an Impingement Mortality (IM) Characterization Study, a required component of the CDS.

This Impingement Mortality Sampling Plan fulfills this requirement for the Four Corners Generating Station. Additional biological monitoring might be desirable depending on the specific compliance approach being used. Given that a compliance approach for Four Corners has not yet been selected at this early stage in the planning process, plans for such additional studies were not included in this document.

1.1 IM CHARACTERIZATION STUDY

The IM Characterization Study is an integral part of the CDS and the overall determination of BTA compliance. The IM Characterization Study provides information needed for development of all subsequent parts of the CDS, including the Design and Construction Technology Plan, the Technology Installation and Operation Plan, the Restoration Plan (optional), a site-specific determination of BTA (if justified), and ultimately the Verification Monitoring Plan. The IM Characterization Study provides data on the rates of impingement mortality currently occurring at the plant, as well as a foundation for estimating the calculation baseline. The Rule requires that the IM Characterization Study provide:

1. Taxonomic identifications of all life stages of fish, shellfish, and protected species in the vicinity of the CWIS and susceptible to impingement;
2. A characterization of these species and life stages in terms of their abundance and their spatial and temporal distribution, sufficient to characterize the annual, seasonal and diel variations in impingement mortality; and
3. Documentation of current impingement mortality of these species and life stages.

In addition to these basic requirements, the IM Characterization Study can provide information necessary for the permit applicant to choose the appropriate Rule compliance alternative, such as applying for a site-specific determination of BTA. To justify this alternative, the results of the IM Characterization Study are needed to evaluate the benefits of implementing technology, operational, or restoration measures, in terms of the numbers or biomass of fish and shellfish potentially saved by their implementation.

The Phase II Rule allows impingement mortality to be quantified either for all taxa or through the use of Representative Species (RS) as part of the compliance assessment. RS are chosen to be surrogates for other species not selected for detailed study. RS typically are those most frequently observed in impingement and entrainment collections, or those deemed to be most important because of their economic value (e.g., commercially or recreationally exploited species), value to the ecosystem (e.g., abundant prey species), or societal value (e.g., threatened or endangered species). Since biological information necessary to complete analyses for the CDS are not available for all species, we believe it is both more practical and more technically defensible to base all analyses on RS. In this sampling plan, we provide the technical rationale for the RS likely to be used for Four Corners.

1.2 SAMPLING PLAN OBJECTIVES AND ORGANIZATION

This Impingement Mortality Sampling Plan has been prepared to meet the following objectives:

1. To identify and summarize existing data on the fish community in the vicinity of the station's CWIS;
2. To identify and summarize existing data on fish impingement mortality within the station's CWIS;
3. To evaluate the sufficiency of existing data to describe the current fish abundance and spatial and temporal distribution of fish in the vicinity of the station's CWIS, and the current rates of impingement mortality;
4. To make an initial selection of RS; and
5. To prepare a work scope for a monitoring program to quantify impingement mortality at Four Corners.

This sampling plan is organized to first present background information on the station, including the source waterbody (Section 2.1), the cooling water intake design and operation (Section 2.2), historical biological data (Section 2.3), and a discussion of the need for data for the IM Characterization Study (Section 2.4). Section 3 describes the fish community in the vicinity of the station's CWIS, using available historical data. Section 3 also briefly summarizes life history information for RS. Section 4 describes the recommended sampling scope for impingement monitoring. This program work scopes describes the recommended sampling design, sampling gear and its deployment, sample processing procedures, collection of any required ancillary information, and data analysis. Section 5 provides recommendations for a quality assurance program, which will address data quality concerns.

2. BACKGROUND INFORMATION

This section presents a summary of available information on the Four Corners Generating Station regarding its source waterbody, Morgan Lake; the design and operation of the facility; and previous biological studies at the station and in the source waterbody.

2.1 SOURCE WATERBODY

The Four Corners Generating Station is located on Morgan Lake, which is on Navajo Indian Reservation Tribal Lands in northwestern New Mexico near the town of Fruitland in San Juan County, approximately 17 miles southwest of Farmington (Figure 2-1). Morgan Lake was constructed during 1959 to 1961 to serve as a cooling water reservoir for the station and a water source for BHP's Navajo Mine. Morgan Lake was formed by constructing an earthen dam at the western end of a natural basin south of the San Juan River. Dikes with spillways were built on the south and east sides for water level control. Morgan Lake has a surface area of approximately 1,200 acres and a storage capacity of 39,000 acre-feet at a surface elevation of 5327.5 feet above mean sea level.

Morgan Lake is described further in Section 3.1, Aquatic Habitat.

2.2 INTAKE DESIGN AND OPERATION

Cooling water is withdrawn from Morgan Lake into an intake canal, which has a 120-foot long skimmer wall barrier at its mouth (Figure 2-2). The opening beneath the skimmer wall was built to be 9.5 feet high, but clearance is now about 6 feet due to siltation. Lake depth at the skimmer wall is about 50 feet. The canal serves Units 1, 2 and 3, and a branch of the canal extends around to the rear of the station where it terminates at the intake structures for Units 4 and 5.

Units 1, 2 and 3 share a 115.5-foot long intake structure that contains nine bays: two 9.75-foot wide bays each for Units 1 and 2, four 11-foot wide bays for Unit 3, and a 6.17-foot wide service water bay. The intake contains seven traveling screens, i.e., two screens per unit plus a service water screen. The Unit 1 and 2 screens are 8.5 feet wide, the Unit 3 screens are 10 feet wide, and the service water screen is 5 feet wide. The screens have ¼-inch woven wire mesh and can be rotated at either 5 fpm or 10 fpm. Typical operation includes screen rotation once per day, but the screens will rotate automatically based on the head differential. Debris and fish are washed from the front of the screens into a sluiceway that leads to the intake canal branch for Units 4 and 5.

Units 4 and 5 share an 84.5-foot long intake structure, which contains four bays (two per unit) and four 14-foot wide traveling screens. There are no trashracks. Screen mesh size is 3/8-inch, and screens are rotated automatically based on head differential. Debris and fish are washed off the screens into a common sluice that leads to a large rectangular mesh collection basket placed within a pit at the end of the sluiceway and row of screen housings. Fish and debris in the collection basket are then disposed, with no means for return to the lake.

Cooling water from all units is discharged to the lake via a canal at a location east of the facility.

2.3 HISTORICAL DATA

The limnology and biological community of Morgan Lake has been studied since the creation of the lake in the early 1960's. These studies have documented the progression of the biological community as the heated discharge was added to the lake and as various fish and other species were introduced into the community. Morgan Lake is managed as a recreational lake and fishery by the Navajo Department of Fish & Wildlife (NDF&W) and the U.S. Fish and Wildlife Service (USFWS). Fish impingement at the station has never been monitored. The following sections briefly describe previous studies on the fish community of Morgan Lake and the type of information available from these studies.

2.3.1 Impingement Studies

No formal impingement studies have been conducted at the Four Corners Generating Station, so there are no historical data on species impinged or rates of impingement. However, visual observations made on September 10, 2004 indicated that the bulk of fish currently being impinged are gizzard shad, with occasional sunfish, channel catfish, or other species.

2.3.2 Fish Community Studies

In a February 1966 report, Southern California Edison Company chronicled the information recorded on the fish, wildlife, and recreational use of Morgan Lake from its creation in 1961 through 1965 (SCE 1966). Information provided included successful and failed stocking efforts beginning in October 1961, accidental introductions of fish species to the lake, seasonal thermal stratification and dissolved oxygen concentrations, disease and parasitism documentation, effects of added thermal inputs, evidence of natural reproduction of fish species, lake productivity and trophic relationships, and water chemistry.

In 1966, Edward Schmidt began graduate research on Morgan Lake that continued until 1970 (Schmidt 1970). He kept a daily log that included information on fish, wildlife, and aquatic vegetation; weather conditions; water chemistry; seasonal temperature and dissolved oxygen (DO) profiles; diseases and parasitism; growth rates of fish; thermal tolerance testing in experimental ponds located adjacent to the discharge canal; lake productivity and trophic relationships; observations of fish impingement on the station's traveling screens; recreational fishing; and movements of tagged fish.

Northern Arizona University conducted aquatic studies on Morgan Lake for APS from 1975 through 1977 (Blinn et al. 1975, 1976, 1977). These studies continued the overall monitoring program of the lake begun in the 1960's, as the limnology and fish community evolved under added thermal loading. These studies documented the composition and relative abundance of species in the fish community; the occurrence of fish kills; annual variation in seasonal water temperatures and DO; seasonal and annual benthos, zooplankton and algal abundance; and fish spawning. In 1975, sampling was limited to physico-chemical measurements and phytoplankton from late May until mid-September. In 1976, sampling was extended to include zooplankton and fish, and in 1977 benthos sampling was added. In 1976, sampling occurred monthly from June 10 to October 1. Sampling in 1977 also was monthly, from March 25 to September 8. Fish were sampled using 21.3-m x 1.8-m variable mesh (2.5, 3.8, 5.0 and 6.4 cm) gill nets set for 24 hours at the surface, thermocline, and bottom at mid-lake locations. In 1977, the shoreline of the island near the terminus of the discharge canal was added as a gill net sampling location. A 6.1-m x 1.0-m seine with 3-cm mesh was used to sample the shoreline during June 1976 and June 1977. Data recorded by species from all samples included numbers captured, lengths, weights, gonadal weights, reproductive condition, and stomach contents.

The NDF&W and the USFWS continue to collect data on fish in Morgan Lake as part of the management activities for the lake's recreational fishery. A fisheries survey was conducted in November 2004 and another survey is proposed for March 2005. Data from the November 2004 survey were not available at the time of the preparation of this sampling plan.

Available results from the studies discussed above are incorporated into a description of the fish community presented in Section 3.2.

2.3.3 Sufficiency of Existing Information for IM Characterization Study

As described in Section 1.2, the IM Characterization Study requires biological data on the following:

1. Identification of fish and shellfish life stages and species in the vicinity of the CWIS and susceptible to impingement;
2. Their abundance and spatial/temporal distribution, sufficient to characterize the annual, seasonal and diel variations in impingement mortality; and
3. Documentation of current impingement mortality of these species and life stages.

As demonstrated above, there is some information available on the fish community of Morgan Lake. However, most of the information is dated.

The requirement for documentation of current impingement mortality at Four Corners would not be satisfied, since formal impingement monitoring has not been previously conducted. Therefore, an impingement monitoring program is proposed to document diel, seasonal and annual impingement mortality that reflect the current status of the fish community and the current intake operation.

The remaining sections of this sampling plan are devoted to describing the fish community for the purpose of a preliminary selection of representative species and to outlining a recommended sampling scope for monitoring impingement at Four Corners.

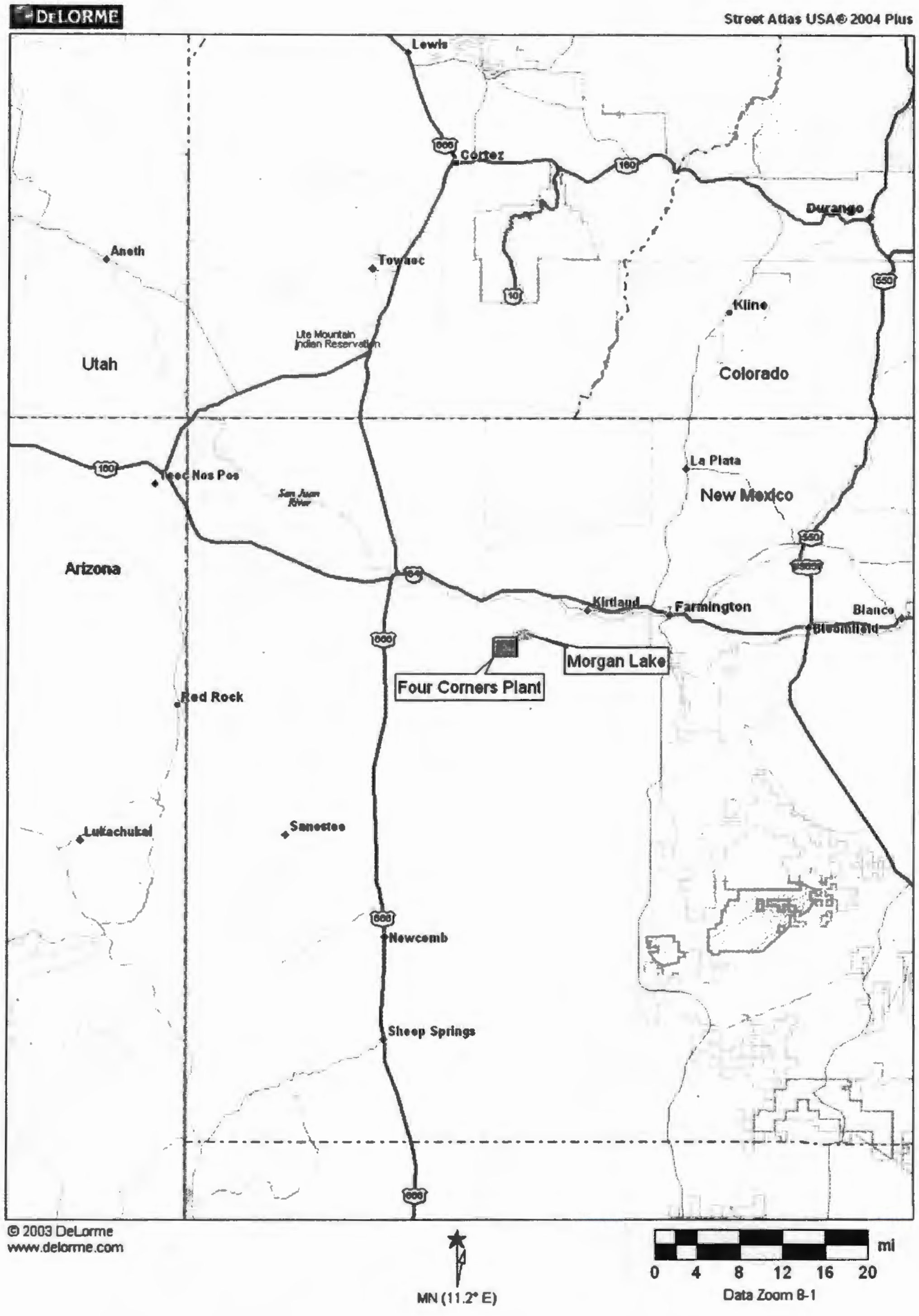

Figure 2-1 Location of the Four Corners Generating Station.

Figure 2-2 Aerial view of the Four Corners Generating Station.

3. FISH COMMUNITY

This section describes the aquatic habitat and the fish community of Morgan Lake. A preliminary list of Representative Species for detailed study is then recommended for the Four Corners Generating Station on the basis of their apparent abundance in the lake or importance due to their economic value, ecosystem role, or protected status.

3.1 AQUATIC HABITAT

At full pond with the surface elevation at 5327.5 feet above mean sea level, Morgan Lake has a surface area of 1200 acres and storage of 39,000 acre-feet. Average depth in the lake is approximately 15 m (49.2 feet). The lake stratifies during warm months, which results in dissolved oxygen (DO) deficits in the hypolimnion. In 1977, the thermocline began to form in late May at a depth of 14 to 16 m, and the lake remained stratified until September 1 (Blinn et al. 1977). Maximum water temperatures (33 °C) were reached by the end of June. When surface water temperatures reached 33 °C, DO saturation levels were less than 50 percent in the epilimnion (3.1 mg/l) and were as low as 0 percent in the hypolimnion. In the spring, turbidity increased as the result of the inflow from the San Juan River carrying sediments from spring runoff. Overall Secchi disc transparency (0.6-1.3 m) may have been reduced to some degree by the fly ash load in the water column (Blinn et al. 1977). The pH ranged from 8.1 to 8.7 during the March to September study period in 1977.

As the lake environment evolved under the increased thermal loading from the station's discharge, changes in the biological community were noted, including the elimination of species that could not adapt to the thermal loading and its effects. In 1977, zooplankton populations were observed to decrease in favor of dominance by blue green algae as water temperatures increased and DO concentrations decreased (Blinn et al. 1977). Benthic populations (primarily chironomids and oligochaetes) also declined from the effects of increased temperatures, which together with decreased zooplankton resulted in a decreased forage base for fish. Fish kills occurred in some warmer summers, such as 1973 and 1974, from stress brought on by the higher water temperatures and lower DO concentrations, and possibly related to the decline in the condition of fish species attempting to adapt to the lake's environment. This phenomenon was not as apparent in the summers of 1975 through 1977 (Blinn et al. 1976, 1977). Hypoxic conditions in the hypolimnion restricted fish and plankton distribution to the shorelines or above the thermocline during the summer.

More recent data on the health of the ecosystem were not available at the time of the preparation of this sampling plan. NDF&W recently has conducted mercury and fish tissue analysis for the lake, but the results were not available. A recent accidental introduction of gizzard shad to Morgan Lake has resulted in an abundance of this species, and likely a major shift in the trophic relationships of the lake.

3.2 COMMUNITY COMPOSITION

When Morgan Lake was created in 1961 there was concern over the species that would become established in the lake to create an active sport fishery, and whether they could adapt to the thermal environment. In October 1961, rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*) were stocked when there was no thermal input to the lake (SCE 1966). Rainbow trout stocking continued in 1962, as well as threadfin shad

(*Dorosoma petenense*) in April 1962. In this year, it became apparent that some species, such as fathead minnow (*Pimephales promelas*) and the native species speckled dace (*Rhinichthys osculus*), also had been introduced unintentionally to the lake, possibly from the San Juan River. In 1963, black bullheads (*Ameiurus melas*) were discovered in the lake, and threadfin shad were again stocked. Largemouth bass (*Micropterus salmoides*) were stocked as fingerlings in July 1963. After Unit 2 went on line, rainbow trout appeared to have succumbed to the increased thermal loading and to an infestation of parasitic anchor worms by August 1963. Threadfin shad did not appear to take on, so this species was stocked again in the spring of 1964, along with northern pike (*Esox lucius*). In the fall of 1964, the exotic species *Tilapia mossambica* was stocked. Green sunfish (*Lepomis cyanellus*) became established in the lake in 1965, and fingerling channel catfish were stocked again to supplement natural reproduction. By 1966 largemouth bass and channel catfish became the dominant sport fish species in the lake. *Tilapia* were eliminated by winter temperatures below their lower lethal limit (55 °F), and fathead minnows and northern pike were much reduced in abundance due to predation or lack of natural reproduction. Bluegills (*Lepomis macrochirus*), flannelmouth suckers (*Catostomus latipinnis*), and desert minnow (*Lepidomeda* sp.) were discovered in the lake. The flannelmouth sucker is a native species for this drainage basin.

By 1976, gill net catches in Morgan Lake were dominated by common carp (*Cyprinus carpio*) and channel catfish, with green sunfish and the native species bluehead sucker (*Catostomus discobolus*) present in much smaller numbers (Blinn et al. 1976). Some species present during the 1960's may have been eradicated during the fish kills experienced in the summers of 1973 and 1974. Sampling in 1977 found channel catfish, common carp, and bluegill to be the numerically dominant species. Green sunfish, largemouth bass, black bullhead, and western mosquitofish (*Gambusia affinis*) were less abundant.

More recent data on fish species composition and relative abundance in Morgan Lake are not available. NDF&W states that largemouth bass, channel catfish and green sunfish are now the primary game fish species in the lake. Bluegill previously were abundant and were the preferred forage species for largemouth bass, but a die-off of bluegill recently occurred and the population has not rebounded (personal communication, Jeff Cole, NDF&W). Summer fish kills from high temperatures and low DO concentrations have reduced the populations of both largemouth bass and bluegill. Gizzard shad is now serving as the primary forage species although it is considered a nuisance species by the fisheries management agencies. Gizzard shad apparently were introduced to the lake accidentally in a shipment of largemouth bass from a national fish hatchery in Texas. Fathead minnows and green sunfish also are important as forage fish.

NDF&W is managing Morgan Lake as a quality fishery for largemouth bass, which currently is requiring stocking of 4,000 8-inch long largemouth bass every other year. Stocking in the future may become annual. When available, 4000 to 8000 channel catfish also are being stocked. Stocked fish come from the national fish hatchery system in Texas or are removed from the San Juan River as non-native species as part of the recovery efforts by the San Juan River Recovery Implementation Program for two endangered species, the Colorado pikeminnow and the razorback sucker (see Section 3.2.1).

Several species other than those reported in previous studies likely occur in Morgan Lake, including aquaria fish species introduced by the public, such as pacu (*Piaractus brachypomus*) and *Plecostomus* catfish (personal communication, Jeff Cole, NDF&W). Impingement sampling at Four Corners may identify additional fish species in the lake.

3.2.1 Gizzard Shad as a Nuisance Species

The NDF&W in January 2005 identified nuisance species, including the gizzard shad, as those species that were inadvertently introduced into Morgan Lake. These species negatively impact the management of recreational sport fish and preferred prey species and may even pose a risk to threatened or endangered species in nearby waterbodies (i.e. San Juan River fisheries management and recovery projects). In 1999 the USFWS identified gizzard shad in Morgan Lake as a threat to the downstream systems and had considered methods for extirpating the gizzard shad from Morgan Lake (e-mail correspondence). Although gizzard shad are an abundant forage species, APS proposes to exclude the gizzard shad from the IM Characterization Study in concurrence with the management interests of the Navajo Department of Fish and Wildlife (NDF&W letter, dated January 2005).

3.2.2 Protected Species

No regional native fish species have been found in Morgan Lake (personal communication, Jeff Cole, NDF&W). Therefore, none of the species collected from the lake are currently listed or proposed (http://www.endangeredspecie.com/states/nm.htm) as endangered or threatened species or species of concern.

Four of 14 fish species native to the upper Colorado River basin are listed as endangered (http://www.r6.fws.gov/coloradoriver/Crovervu.htm): Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), bonytail (*Gila elegans*), and humpback chub (*Gila cypha*). Of these, only the Colorado pikeminnow and razorback sucker are native to the San Juan River, the water source for Morgan Lake. Efforts to reestablish these two species in the San Juan River are led by the San Juan River Recovery Implementation Program (SJRIP), formed in October 1991 by the States of New Mexico and Colorado, USFWS, U.S. Bureau of Reclamation, U.S. Bureau of Indian Affairs, U.S. Bureau of Land Management, and several tribes including the Navajo Nation.

The stated goals for the SJRIP are to reestablish the endangered fish in the San Juan River Basin and to accommodate the needs of future water development. Recovery of the two endangered species is being pursued by directed research on the river, stocking of the two species, and water flow management, potentially through seasonal releases from the Navajo Dam mimicking a natural hydrograph and water rights management. Morgan Lake may be the recipient of non-native fish intentionally transplanted from the San Juan River in an effort to reduce competition and predation on the two endangered species and other species native to the river. Presently, there is only very limited natural reproduction of the Colorado pikeminnow in the river (Platania et al. 2000) and no wild razorback suckers have been found there (Ryden 2000a, 2000b).

3.3 REPRESENTATIVE SPECIES

Representative Species (RS) typically would be those most frequently observed in impingement collections, or the most important based on their economic value, value to the ecosystem, or protected status. In addition to being the target species for evaluating compliance with impingement mortality reductions, RS can be used to estimate the economic losses by fish impingement mortality for a cost-benefit analysis under the EPA site-specific compliance alternative #5 or for scaling restoration efforts and verifying the success of restoration alternatives. It would be important to collect length, weight, and age data from RS during the impingement monitoring program in order to estimate individual growth rates and biomass production for species used in the cost-benefit and restoration analyses. Such detailed analyses would not be possible or practical for all species impinged. Therefore, RS would serve as surrogates for other species of less critical importance or abundance.

Since no impingement monitoring has been conducted at the station, a preliminary selection of RS instead can be made based on current abundance in the lake and importance as either forage species or recreational species. Three species are proposed as potential RS because of their importance to the recreational fishery of Morgan Lake and the possibility that they will be among the more frequently impinged species. These species are the largemouth bass, channel catfish, and green sunfish.

This section presents the rationale for choosing each species, along with a brief summary of its life history. As impingement monitoring progresses, this list could be modified to reflect actual conditions.

3.3.1 Largemouth Bass

The largemouth bass is a candidate RS because of its importance as a recreational species and a predator at the top of the food chain. Morgan Lake is actively managed by NDF&W as a largemouth bass fishery. NDF&W regularly stocks 8-inch bass into the lake to maintain the fishery, since natural reproduction of this species in Morgan Lake may be limited and survival may be reduced by summer water temperatures and low DO. Preferred water temperatures range from 26.6 °C to 27.7 °C, and DO concentrations must be above 1.5 mg/l (Emig 1966a). At this time, the extent of impingement of largemouth bass at the Four Corners Generating Station and the relationship of stressful temperatures or DO conditions to impingement are unknown.

In most locations, largemouth bass spawn in May-June when water temperatures reach 60-75 °F (15.5-23.9 °C). The male builds a nest in substrate that typically is rocky or gravel, but may include submerged vegetation or at least a silt-free environment. The nests are 2-3 feet in diameter and usually widely spaced (e.g., 30 feet apart) unless the available nesting area is limited. Nests are built in areas of no current or wave action at depths of 1 to 15 feet. More than one female may spawn in a nest. Males remain at the nest to fan the eggs to keep them silt-free and to protect the young for up to 2 weeks (Pflieger 1997). Eggs hatch in 3-4 days and the fry form tight schools over the nest and begin to feed in 5-8 days. The schools break up approximately 1 month after hatching and when the young bass are approximately 1 inch long. Growth rates are variable and depend on the lake productivity and food availability. Largemouth bass mature at about ages II to III, or about 10 inches in length (Pitlo et al. 2004a).

Adult largemouth bass typically spend the daylight hours at depths near submerged structures and move into shallow water at night to feed. They remain within a home area both in summer and in winter, but the summer and winter areas may be distant from each other. Like other species in Morgan Lake, their seasonal distribution in the lake will be determined by the local thermal and DO environment. Their growth and abundance is related to the availability of their forage base.

Unless natural reproduction of largemouth bass is significant in Morgan Lake, the vulnerability of this species to impingement would be reduced, since they would occur primarily as adults of a stockable size (8 inches) or larger.

3.3.2 Channel Catfish

The channel catfish also has been an important recreational fish species in Morgan Lake and apparently is relatively abundant, indicating it has adapted to the thermal environment of the lake. It is a large predator, in some locations reaching more than 25 pounds and 36 inches (Smith 1985, Pitlo et al. 2004b). In the early stages of the lake's development, it was apparent that natural reproduction of channel catfish in Morgan Lake may have been limited. Whether or not channel catfish are now successfully reproducing is uncertain. NDF&W continues to stock this species into the lake.

Channel catfish spawn in May and June when water temperatures reach 65°F or more (Pitlo et al. 2004b). Often there are two or more spawning peaks. Several weeks prior to spawning, males select and clear suitable nest sites, usually consisting of secluded, dark areas such as hollow logs, drift piles, undercut banks, muskrat or beaver burrows, or rip rap. Eggs are deposited in a gelatinous mass. The male tends the nest while eggs hatch and stays there for about 1 week to guard the fry. Early growth is variable among year classes and apparently is dependent upon existing conditions (Pitlo et al. 2004b). Channel catfish begin to mature at age IV and 12 inches in length, and 75 percent are mature by age VI.

Adults may be found in many habitats but in daylight appear to prefer cool, deep areas with woody debris, bank cavities or other structure (Koel et al. 1998). Adult channel catfish will feed in daylight or darkness, but at night they tend to feed in shallower depths.

3.3.3 Green Sunfish

Green sunfish have been documented as residents of Morgan Lake since 1965. This species can serve as a forage fish for predators such as channel catfish and largemouth bass, and is a recreational panfish species. The green sunfish is not a native species in New Mexico. It is tolerant of a wide range of environmental conditions including turbidity and silt loading, DO concentrations, flow and temperature (Smith 1985, Pflieger 1997). This tolerance may be the reason why this species persisted in the lake after die-offs of bluegill and largemouth bass caused by low summer DO levels.

Green sunfish begin to spawn as water temperatures reach 68 to 70°F, and continue spawning, often until early August or when temperatures reach 82 °F (Smith 1985). Males build nests in water typically 1 foot deep or less, or in areas protected by rocks or logs. Nests often can be grouped by green sunfish are not considered to be colonial spawners (Pflieger 1997). Eggs hatch in 3 to 5 days, and fry leave the nest after an additional 6 or 7 days. The male fish will tend to the nest and young during this period. This spawning process can be repeated in a single season.

Adult green sunfish are usually associated with areas of vegetation or shelter. Sexual maturity is reached at age II (Smith 2002). Green sunfish can live up to 4 or 5 years and reach 12 inches or 2 lb in size, but few exceed 9 inches in length or 0.75 lb (Pfleiger 1997).

4. PROPOSED IMPINGEMENT MONITORING

As discussed in Sections 2.3.1 and 2.4, impingement data have not been collected previously at the Four Corners Generating Station. The objective of the proposed impingement monitoring plan is to design and implement a program that will produce accurate estimates of impingement rates under rigorous quality assurance/quality control procedures. Data produced by this monitoring program will define the species and life stages impinged, as well as their numbers and biomass on a time (diel, seasonal, and annual) and per-volume-pumped (million gallons of cooling water) basis. The results will be incorporated into the IM Characterization Study, as described in Section 1.2.

This section addresses the proposed sampling plan, sampling methods, sample processing procedures, collection of relevant ancillary information, and data analysis. A quality assurance program for the impingement monitoring program is described in Section 5.

4.1 SAMPLING DESIGN

The impingement monitoring program is recommended to span at least one year (12 months) and to include both intakes and all five units. A decision on a second year of monitoring can be made once the magnitude of impingement and/or the species and life stages impinged becomes apparent. Impingement will be sampled at both intakes at the same time. If either intake is not scheduled to operate during the specified sampling period, a request will be made to turn on a circulating water pump for the duration of sampling in order to get representative density measurements for impinged fish for that intake.

Sampling frequency will be biweekly over a 12 month period. Samples will be collected over a 24-hour period during each biweekly period. Sampling days will be scheduled for the same day(s) in each period (e.g., Tuesday-Wednesday). One sample will be taken every 12 hours according to the following time intervals: 0600-1800 hours and 1800-0600 hours.

4.2 SAMPLING GEAR AND DEPLOYMENT

Prior to sampling, the traveling screens of both intakes will be rotated for at least one full cycle to remove fish and debris accumulated prior to the sampling interval. Once this cleaning process has been accomplished, the sampling will be initiated by placing a collection device in line with the screen wash troughs of each intake. For the Unit 1-3 intake, the collection device could consist of net frame and net gear (Figure 4-1) set into the screen wash trough on the screenhouse decking downstream from the screen housings. Two sets of this gear would be recommended, placed in series so that when one net is being removed, the second net would be in place to continue the sampling. Alternatively, a collection basket could be installed at the end of the Unit 1-3 screenwash trough, possibly suspended off the end of the intake deck. For the Unit 4-5 intake, the existing collection basket at the end of the screen wash sluice can be used with a removable net liner of the proper mesh size placed inside the collection basket and removed at the conclusion of the sample. The collection baskets or nets will have ¼-inch mesh.

The collection baskets (or nets) will be left in place for as long as possible, up to the entire 12-hour collection period, and the duration of the sample will be recorded. If fish or debris volumes become too great, screens will be rotated and washed as frequently as necessary to reduce the volume of debris and fish being directed to the collection baskets at once. If necessary, screen rotation will be continuous, in which case the sampling crew will monitor the screen washwater troughs and the collection baskets to prevent snags or overflow. To prevent collection basket overflow, the crew will temporarily interrupt sampling, empty the collection basket's contents, and resume sampling, while recording the start and end times of the interruption. Total impingement during the 12-hour sampling period will be estimated by extrapolating from the timed sample(s) to a full 12-hour sample.

At the completion of the sample collection, the collection baskets will be removed and their contents will be emptied onto a processing table. Collections from the Unit 1-3 intake will be maintained separately from collections from the Unit 4-5 intake. This sampling process will be repeated during the second 12-hour sampling interval in the 24-hour sampling period.

Two times during the year a test of impingement collection efficiency will be conducted at each group of intakes. Approximately 100 specimens each of species and sizes representative of dominant fish species being impinged will be marked (e.g., with a fin clip or biological stain) and released in front of the screens at each intake at the start of the 24-hour sampling period. These specimens will have been collected during previous weekly samples and frozen for use in these tests. The recovery of these marked specimens will be recorded during the subsequent sampling, separate from the impingement counts. The results will indicate the efficiency of collection of impinged fish from the traveling screens. The data can be used to adjust impingement collection statistics to reflect the estimated total impingement for samples consisting of fish species that these test specimens would represent in terms of size and shape.

4.3 SAMPLE PROCESSING

Samples from the two intakes will be processed separately. Each screen sample will be processed by counting and identifying all fish to the lowest practicable taxonomic level. Individuals that cannot be identified to species in the field will be preserved for identification by taxonomic specialists.

Fish in the sample will be sorted by species and size category. Two size categories will be established prior to sampling, if possible, to separate young-of-the-year (YOY) individuals from yearling and older individuals. Size categories will be determined according to cut-off lengths used during the previous weekly sampling period and anticipated growth, based on observation and literature sources. Following sorting, up to 50 randomly chosen individual specimens within each size category will be measured to the nearest mm total length (TL) and their condition will be recorded as live, dead or stunned. A total batch weight measurement will be taken for each size category.

If the number of specimens in the sample for a particular species and size category is large, then the species/size category count will be estimated by subsampling. A subsample of 100 randomly chosen individuals will be weighed and the total sample will be weighed. The number of individuals in the whole sample will be estimated from the ratio of the total sample weight to the subsample weight total and the count within the subsample. Lengths will be measured for 50 randomly chosen individuals in the subsample.

Quarterly the scales, spines, fin rays and/or otoliths (depending on species) from 20 measured yearling and older individuals of each of the RS from each 50-mm length interval (e.g., 200 – 249 mm, 250 – 299 mm, etc.) will be removed and stored in individual envelopes or glass vials. For each sampled fish, the collection date and location, species, and total length will be recorded. These samples will be collected in anticipation that age information for older individuals may be required for application of equivalent loss models as part of a site-specific cost-benefit calculation.

The general condition of impinged organisms will be observed as they are processed. Unusual condition, such as signs of disease, parasites or injury, will be noted. Fish that were obviously dead before being impinged (e.g., presence of fungus or decay) will not be included in the sample. Indications of a mass die-off of fish will be observed and recorded, and examples of physical evidence (e.g., floating fish in the lake or dead fish on shore) will be photo-documented. If available, scientifically defensible methods to detect or predict the occurrence of moribund fish entering the intake will be used to document episodic impingement events that would represent anomalous impingement data.

Samples may be frozen at the completion of processing and saved for possible inclusion in quality control (QC) testing. Once it is determined that a sample is no longer needed for QC purposes, the sample will be disposed of in an approved manner. QC of sample processing is discussed in Section 5.

4.4 RELEVANT ANCILLARY INFORMATION

There is ancillary information that will be recorded relevant to environmental conditions at the time of impingement monitoring, as well as plant operation data needed to estimate total impingement. Environmental data relevant to each sample will be recorded on an accompanying field data sheet. In addition to date and sample start/end time recordings, these data will include operation parameters for the intake (identify screens and pumps operating); and water temperature, dissolved oxygen concentration, and conductivity, all recorded at the beginning and end of each 24-hour collection period. A unique sample identification number will be assigned to each sample. Other relevant observations may be recorded, including weather conditions, such as air temperature, wind speed and direction, cloud cover, precipitation, etc.

Plant operation records will be obtained to determine the operation regime during the sampled and unsampled days in each month. Data required include hourly pumping rates (or volumes) for each unit, generation output (MWh) and discharge water temperature. Pumping rate or volume data will allow impingement estimates to be based on per unit volume pumped.

4.5 DATA ANALYSIS

The objectives of the impingement data analysis will be to:

1. define the fish species impinged;
2. estimate impingement rates expressed as density per million gallons (MG) of cooling water pumped on a diel, biweekly, and annual basis;
3. estimate total numbers and biomass by species on a daily, biweekly, and annual basis for the year of sampling; and
4. characterize impinged fish in terms of size and age distribution by species.

The results will be incorporated into the IM Characterization Study in the CDS, as discussed in Section 1.2.

The estimated total numbers and biomass impinged will represent the actual impingement for the year of sampling. However, the impingement rates expressed as density per million gallons (MG) of cooling water pumped can be used to estimate impingement totals under differing operating scenarios, such as might be required to determine the calculation baseline for the station.

To estimate the density of impinged organisms for a particular species, the number of fish of that species collected at each intake (adjusted for collection efficiency) will be divided by the total intake flow during the 24-hour sampling period. This density estimate then will be multiplied by the total intake flow during the biweekly period to estimate the total number of impinged fish for the biweekly period. Annual totals will be the sum of all biweekly totals. The same calculations will be performed for estimating total biomass impinged using weight totals.

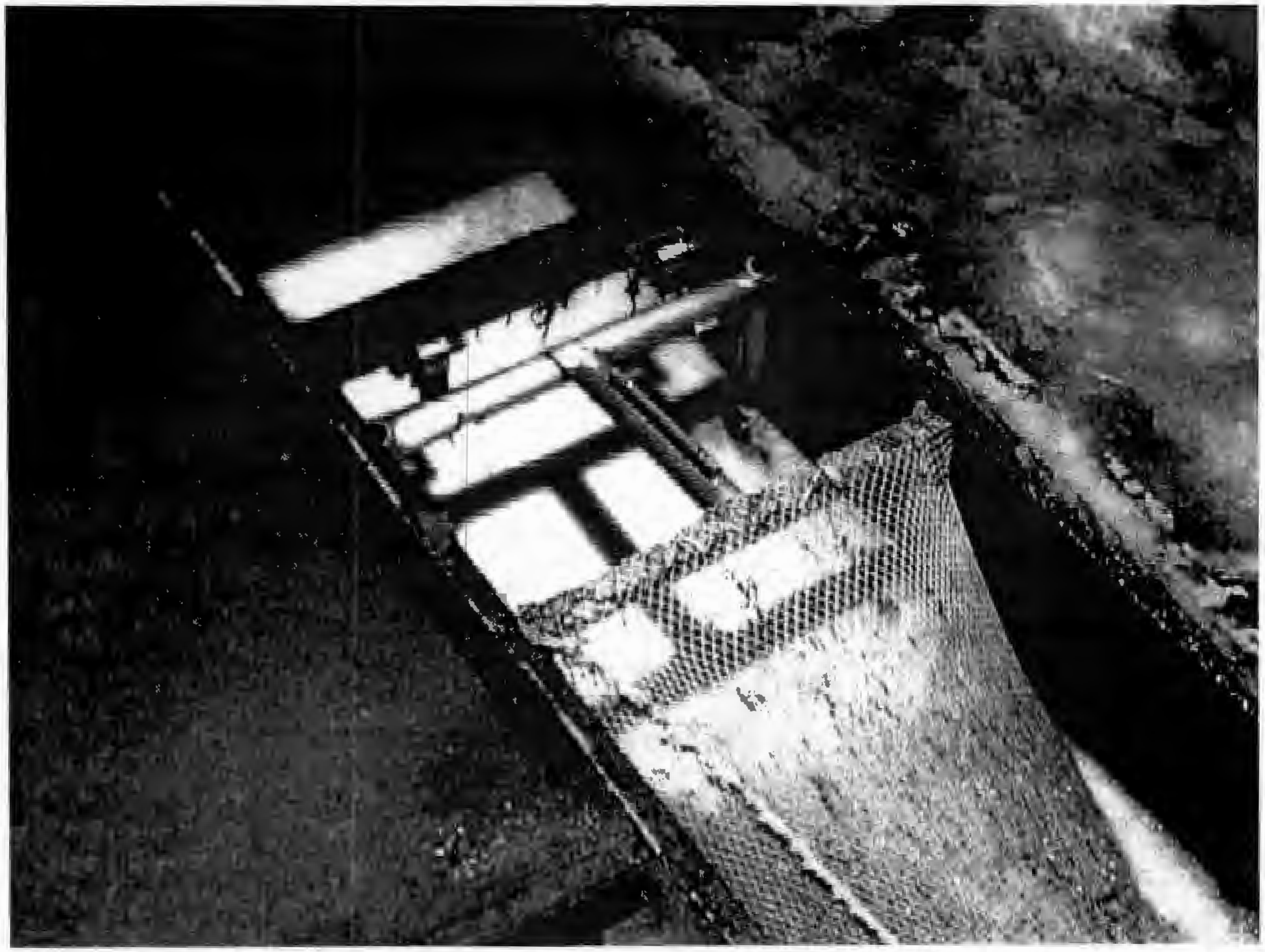

Figure 4-1 Impingement sampling net and frame set in floor trough.

5. QUALITY ASSURANCE

An essential part of the proposed monitoring program will be a quality assurance plan instituted to ensure that the data generated by the program meet an acceptable standard of quality. Quality assurance (QA) is defined as an integrated system involving quality planning, quality control, quality assessment, quality reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. The EPA has published guidance documents (e.g., EPA 2000; 2002a, 2002b) for preparing and implementing project-specific quality assurance plans for their staff and for contractors funded by their organizations to follow, known as Quality Assurance Project Plans (QAPPs). These documents will be used to prepare a QAPP that fits the needs of the proposed impingement program prior to the initiation of sampling.

A QAPP has four basic element groups: project management, data generation and acquisition, assessment and oversight, and data validation and usability. The following highlights aspects that are particularly relevant to the execution of the program.

5.1 PROGRAM MANAGEMENT

This Impingement Mortality Sampling Plan provides many of the elements necessary for the program management functions of a QAPP, such as problem definition and background, and project and task descriptions. Other program management functions of a QAPP that are provided in the Plan include presentation of the project objectives and the interrelationships among the project tasks that direct the course of studies and identify information endpoints. An important element is the project organization, which identifies the roles and responsibilities of project personnel. A project organization chart identifies project personnel, whose qualifications (e.g., experience and specialized training) can be reviewed, as well as lines of communication and authority. The project organization chart will show individuals whose responsibility is to conduct various aspects of the quality assurance program.

The QAPP will set data quality objectives and criteria. Methods will be specified to ensure the desired level of precision, comparability, and completeness. In terms of impingement mortality quantification, the EPA has not set standards for precision of estimates, so the sampling design proposed in this Plan conforms to sampling effort and precision levels that currently are standard practice. If the EPA publishes guidance on sampling methods in the future, including QA standards and desired or required levels of precision, the program design and methodology will address these standards.

5.2 DATA GENERATION AND ACQUISITION

This component of the QA program is the heart of the field and laboratory tasks undertaken to generate data on current impingement rates at Four Corners. Elements include sampling design, sampling methods, sample handling and custody, analytical methods, instrument maintenance and calibration, and quality control. Quality control is defined as activities whose purpose is to measure and control the quality of a procedure so that it meets the needs of its user. Quality control (QC) activities monitor the outgoing quality of the data and can lead to response actions to bring the data within control limits through various actions, such as retraining of personnel, repair or recalibration of equipment, or other similar actions.

Sampling methods will be standardized so that they are repeatable and produce data that are comparable through time. This will be accomplished by preparing detailed Standard Operating Procedures (SOPs) for all activities, including sampling location and frequency, sampling gear and deployment, sample processing, data coding and recording, database entry, and to some degree, data analysis. The SOPs can be reviewed by all parties to reach consensus on their applicability, and will be adhered to by all project personnel. SOPs will provide a description of procedures to follow if obstacles to sampling or completion of all sampling activities are met, so that the acquisition of quality data can be maximized. The SOPs will describe procedures for sample handling and custody, including required signatures and blank forms for associated labels and logs. Also included will be project-specific data sheets, variable definitions and coding instructions. Equipment and instrument specifications will be described, including levels of precision and calibration methods for ensuring accuracy.

Systematic QC procedures will be instituted to verify recorded data. The primary area where these QC procedures will be used is sample processing, e.g., sorting of impinged fish from debris in the collections, fish counts, species identification, and length and weight measurements. Processed impingement samples will be subjected to a statistically-based QC procedure, such as continuous sampling plans (CSP) or MIL-STD 105 methodology derived from a manufacturing environment and applied to environmental monitoring programs (Young et al. 1992). The sampling plans implemented under these procedures have a specified average outgoing quality limit (AOQL), which represents the maximum fraction of all items (e.g., measurements, taxonomic identifications or counts) or lots (e.g., whole samples) that could be defective as a worst case. A defective item could be a measurement or count that falls outside of a specified tolerance limit (e.g., plus or minus 1 to 10 percent). In practice, the average outgoing quality (AOQ) is typically much better than the AOQL.

5.3 ASSESSMENT AND OVERSIGHT

Assessment and oversight is the process of determining whether the QA plan is being implemented as designed. For the proposed programs, this will be accomplished primarily by conducting technical audits or surveillance of field, laboratory and data management activities. Experienced senior staff, designated by the organization chart, will accompany field personnel during a set number of sampling events to observe sampling activities and to verify that SOPs are being followed properly. These auditors also will observe laboratory and data management personnel during their activities on specified occasions. Variances from approved procedures will be documented and corrected, either by modifying SOPs to address any systematic problems or by testing and/or retraining staff, as necessary. Prior to the first scheduled sampling, a readiness review will be conducted to ensure that trained personnel, required equipment, and procedural controls (e.g., SOPs) are in place. A technical audit will be scheduled for the first month of sampling (or very soon thereafter) so that any necessary corrections can be made before significant data losses occur. Follow-up audits will be scheduled (e.g., quarterly) to monitor progress and address changing conditions, such as recruitment of new life stages or species, impingement abundances, river stage or flow, new personnel, or plant operations.

Another QC aspect for oversight is the maintenance of a voucher specimen collection and library of taxonomic keys and references to assist personnel with taxonomic identification. The voucher specimen collection will consist of preserved specimens that have been positively identified by a qualified taxonomist. Oversight also will be provided by procedures requiring that specimens that are not positively identifiable by field or lab personnel will be preserved and given to a qualified taxonomist for identification.

5.4 DATA VERIFICATION, VALIDATION AND USABILITY

Data verification and validation will be conducted by qualified biologists (e.g., QA manager or field/lab supervisors) during the course of the project to ensure that the resulting data will be suitable for use as intended. Project records, including field sampling logs, raw data sheets, sample chain-of-custody forms and instrument calibration logs, will be reviewed to verify that data were collected according to the QAPP. Data will be validated first by a review of datasheets and data files to find whether data are incomplete or appear to be inappropriate or out of a reasonable range of values. Data entry into the database also will undergo a 100 percent visual QC comparison to the data on the corresponding data sheets. Finally, data files will be subjected to error checking programs to detect outlying values either to investigate further or to eliminate if shown to be spurious. This investigation will require tracing the data to raw data sheets and consulting with field or lab personnel who recorded the data. All raw data sheets, log books and data files will be maintained for future reference. All computer files will be backed up on a daily basis while any data entry or editing procedures are ongoing.

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C. PROPOSED METHOD FOR EVALUATION OF ENVIRONMENTAL BENEFITS

Deriving Economic Benefits of Reduced Impingement at APS's Four Corners Power Generation on Morgan Lake

Background

For use of the Cost-Benefit test under the site-specific standards, APS is required to have a Benefits Valuation Study prepared. The final 316(b) Phase II Final Rule (herein after referred to as the Rule) requires use of a comprehensive methodology to value fully the impacts of impingement mortality at the Four Corners steam electric generating facility on Morgan Lake. Other requirements for use of the test include:

- A description of the methodology(ies) used to value commercial, recreational, and ecological benefits (including non-use benefits, if applicable);
- Documentation of the basis for any assumptions and quantitative estimates. If the valuation includes use of an impingement survival rate other than zero, a determination of impingement survival at the facility based on a study approved by the NPDES permitting authority must be submitted;
- An analysis of the effects of significant sources of uncertainty on the results of the study;
- If requested by the NPDES permitting authority, a peer review of the items submitted by APS in the Benefits Valuation Study. APS must choose the peer reviewers in consultation with the Director who may consult with EPA and Federal, State, and Tribal fish and wildlife management agencies with responsibility for fish and wildlife potentially affected by the facility's cooling water intake structure. Peer reviewers must have appropriate qualifications depending upon the materials to be reviewed.
- A narrative description of any non-monetized benefits that would be realized at the facility if APS were to meet the applicable performance standards and a qualitative assessment of their magnitude and significance.

All benefits, whether expressed qualitatively or quantitatively, should be addressed in the Benefits Valuation Study and considered by the NPDES permitting authority and in determining whether compliance costs significantly exceed benefits.

The benefits assessment begins with an impingement mortality study that quantifies both the baseline mortality as well as the expected change from rule compliance. Based on the information generated by the impingement mortality studies, the benefits assessment includes a qualitative and/or quantitative description of the benefits that would be produced by compliance with the applicable performance standards at the facility site. To the extent feasible, dollar estimates of all significant benefits categories would be made using well-established and generally accepted valuation methodologies.

In order to have the appropriate information if the benefit/cost option is chosen, we propose a strategy for the collection and analysis of economic information. It should be noted that one particular benefit category, benefits accruing to individuals even if they have no plans ever to use Morgan Lake (non-use benefits), are to be estimated only

> "In cases where the impingement or entrainment study identifies **substantial harm** to a threatened or endangered species, to the sustainability of populations of important species of fish, shellfish or wildlife, or to the maintenance of community structure and function in a facility's water body or watershed ." (Final Rule, Federal Register page 41648).

"Substantial harm" is a stringent requirement to necessitate estimation of non-use values and thus non-use values usually would not be included in the final analysis. However, because the Final Rule does raise the potential for estimation of non-use values, we do provide some contingency for their estimation.

Description of Methodologies to Determine Benefits

The 316(b) rule defines a performance standard that the EPA has established for all existing power plant facilities to meet. Because the facility is located on a freshwater lake, only the impingement mortality (IM) performance standard (requiring reduction of IM by 80% to 95%) is required to be met. The PIC in Section 3 identifies a number of technologies that could meet the requirements of the performance standard. However, the Final Rule Option 5 states that facilities do not have to meet the IM performance standard if it can be shown that the costs of achieving the performance standard are significantly greater than the benefits. Therefore we are providing a plan to collect information on benefits to determine whether the costs of the identified technologies are significantly greater than costs of benefits.

At present, there are no studies that investigate IM at Morgan Lake and we must hypothesize which species are likely to be affected by the Final Ruling. The Navajo Fish and Wildlife Department has provided some helpful information on current fishery management. The information supplied indicates the primary game species in the Lake are largemouth bass, channel catfish, and green sunfish. There appear to be no commercial fisheries on the Lakes so that the only benefits accruing from the identified technologies would be recreational values from increased catch and possibly non-use values.

The EPA examined a technology (closed-cycle cooling) to achieve a national standard for entrainment and impingement mortality. In determining benefits at a national level, EPA used certain economic concepts of benefits associated with using the assets that cooling water adversely effects and methodologies to estimate the benefits (U.S. EPA, 2004a; U.S. EPA 2004b; U.S. EPA 2004c). In order to make the benefits comparable to costs, they presented benefits in a monetary unit, dollars. Their benefit estimates reflected the willingness to pay of individuals to go from the current environmental status to one associated with an identified technology. All of the methods proposed in this PIC were also used in EPA's national analysis.

More specifically, this benefit analysis will seek to provide a recreational unit value per fish caught ($/fish) for Representative Important Species (RIS). With this information, total recreational benefits can be determined by multiplying the unit value times the expected increase in recreational catch arising from the identified technology. In addition, some information will be provided with respect to non-use values.

Recreational Angling

For the recreational anglers, there are two potential ways to proceed:

1.) Benefit Transfer- the application of benefit estimates provided in other studies to the Four Corners Station situation;
2.) Primary research- collection and/or assemblage of data on recreational fishing on Morgan Lake and using the data to derive an estimate of the value per fish for the important species.

While the two approaches initially will be discussed independently, there is a sound reason to consider them in concert with one another. That is, the benefit transfer information provides a reality check for any values derived in the primary research. Any primary research effort should contain a thorough literature review, a component that would have information very similar in nature to the benefits transfer analysis. Also, the benefit transfer approach may provide a fallback position if the primary research is unsuccessful in providing benefit estimates. After both have been discussed independently, a strategy that integrates them will be offered.

A Benefit Transfer Approach

The use of benefit transfers requires finding a previous economic study (or studies) that considers a comparable situation to fishing at the Morgan Lake and contains dollar values per unit fish caught. Particularly important would be having species similar to the RIS species and a fishing population similar to the Morgan Lake situation. Although there are numerous other aspects of the fishing situation that might be important, these two are the most critical.

In order to identify an appropriate study or studies, it would be essential to visit the site to examine first-hand the type of recreational fishing that is occurring. At the same time, contact with key people in the area will be made to determine if any relevant studies do exist. We would consider it essential that the following sources be contacted or examined:

1. State or Federal Hearings on previous Four Corners facilities' license renewal.

2. State or Federal Hearings on previous power plant facilities in the general area of Four Corners.
3. Navajo Fish and Wildlife Department personnel.
4. Key Informants at Universities or other research facilities
    a. University of Arizona
       Dr. William Martin had several Masters students that studied sportfishing in Arizona.
    b. New Mexico State University
       Dr. Frank Ward has done several sport fishing studies in the southwest.
    c. University of Wisconsin
       Dr. Richard Bishop analyzed sportfishing for the Glen Canyon Dan project.
    d. University of New Mexico
       Dr. Robert Berrens (Department of Economics)

5. Existing bibliography sources available by internet
    a. National Marine Fisheries Service, Southwest Fisheries Center
    b. Sportfishing Values Database
    c. Environmental Valuation Reference Inventory (EVRI): Canadian based.
    d. Beneficial Use Values Database (BUVD)
    e. Regulatory Economic Analysis Inventory, (REAI) maintained by the U.S. EPA
    f. ENVALUE, an environmental value database maintained in Australia.
6. *Investigation and Valuation of Fish Kills* (American Fisheries Society, 1992) Excerpt: "Chapter 4 ("Monetary and Economic Valuation of Fish Kills") dates back to the Pollution Committee's *Monetary Values of Fish* booklets of 1970 and 1975, which dealt with southern U.S. species. In 1978, the AFS North Central Division's Monetary Values of Fish Committee published *Reimbursement Values for Fish,* addressing species in 12 northern states and 2 Canadian provinces. To integrate these and other regional values, a special AFS Monetary Values of Freshwater Fish Committee collected values from 135 federal, state, provincial, and private agencies and hatcheries. These data were published in 1982 as Part I of AFS Special Publication 13. For the present book, the Socioeconomics Section has repeated the earlier survey to update replacement costs for killed fish and summarized procedures for estimating the broader economic losses resulting from a fish kill."
7. Data from U.S. Fish and Wildlife.

These potential sources will be used to obtain "off-the-shelf" values that could possibly be relevant to the RIS species at Morgan Lake. In addition, some of these contacts may be useful as researchers, data sources, and/or witnesses for any hearings that evolve. They may also be useful as peer reviewers or as sources to identify peer reviewers. This will be the initial thrust of the benefit transfer work.

Primary Research

There are several other methodologies that could be used to determine economic values for the species considered, but they will require substantial primary research. Given the isolated location of Morgan Lake, it may take a large effort to obtain unit value estimates for fish.

As an initial approach, it would be useful to contact Dr. Frank Ward regarding the possibility of using information and analysis associated with a study conducted in 1988/89 on sportfishing demand in New Mexico. The results of the study with some additional analysis could shed light on the unit values of fish in Morgan Lake. In particular, the authors talk about the unit values of additional fish at different lakes in New Mexico but do not present any values.

If these data are not available or do not provide useful information, a study using combined on-site surveys of anglers and mail surveys targeted to residential users of electricity in Arizona, New Mexico, Colorado, and Utah would probably provide the highest quality information. With the data, one could use a demand system approach like Ward et al. or a random utility model (RUM) following the EPA's approach in many of the saltwater regions of the country.

Strategy to Obtain Recreational Unit Values per Fish Caught

The initial portion of the study would be to complete a benefits transfer analysis and determine whether or not the values obtained were reasonable for the purposes of the decisions to be made. That is, if the mitigation strategy returned recreational benefits of $100,000 per year and the corresponding costs were $70,000, it would probably be unwise and inefficient to move onto primary research because in all likelihood the estimate of costs would not be significantly larger than the benefits. If however, the benefit transfer method suggested that the benefits were to be small relative to costs, it may be useful to do one of the primary research plans suggested in the previous section.

Discussions with key informants in the benefit transfer work would determine the

1.) availability and reliability of data from the previous study of the New Mexico recreational fishing.
2.) potential for doing a survey across four states using the approach suggested above.

With this information and a better understanding on the costs of doing the primary research studies, decisions regarding which of the two primary research efforts could be made.

Non-use Valuation

Subsequent study by biologists will determine whether there is a necessity to assess non-use values. Based on current knowledge, it would not be necessary to estimate them (Jules Loos, personal communication). The fact that Morgan Lake is a man-made structure and that the RIS species are stocked reduces greatly the likelihood that the current state of knowledge will change.

But, in the unlikely event that non-use values will have to be estimated, we would look to using a benefit transfer approach or doing primary research for APS. Based on the draft Strategic Compliance Plan for the Four Corners Station (August 2004), we do not believe that the magnitude of the non-use values would justify undertaking a primary research study for non-use values associated with Morgan Lake.

Thus, if non-use values were needed, we would suggest using a benefit transfer method in all likelihood. There have not been any studies of non-use values associated with power plant activities *per se.* People have had to rely on studies associated with other types of activities. For example, EPA used this approach in their Proposal for the 316(b) regulations and in the NODA. EPA (Tudor et al., 2003) reviewed numerous studies of use and nonuse values that were associated with surface water improvements (their Appendix A). Of those shown, only three address both changes in fish populations and non-use values associated with them (Huang, et al. 1997; Whitehead and Groothuis, 1992; Olsen, et al. 1991).

We propose considering these three studies in addition to doing a review of the recent literature. The recent literature may be important because EPA has placed some emphasis on this ecological valuation recently. For example, there is a meeting entitled "Improving the Valuation of Ecological Benefits, a STAR Progress Review Workshop" that was held in Washington in October, 2004.

The results of this activity would likely be the development of a relationship (specifically a ratio) between use values and non-use values. For years, EPA used the 50% rule, a practice that implied that nonuse values were 50% of use values. Our approach, just like some of their 316(b) efforts (Tudor 2003), would be to refine this ratio for situations more akin to the changes associated with power plant operations.

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D. 316(B) RELATED AGENCY CORRESPONDENCE

See following pages.

February 18, 2005

Carl Woolfolk
Mail Station 4915
P.O. Box 355
Fruitland, NM 87416-0355

Dear Mr. Woolfolk:

The purpose of this letter is to document the Department of Fish and Wildlife's position in terms of important fish species present in Morgan Lake.

The important sport fish species in Morgan Like are largemouth bass, green sunfish and channel catfish. The important prey species in Morgan Lake is green sunfish and recent surveys indicate that the sunfish population is down.

There are several species of fish that have been accidentally introduced into the lake and are considered a nuisance due to the fact that they have a negative impact on Management of game fish and prey species in Morgan Lake. In addition, these species would have a negative impact to native fish species, including threatened and endangered fish species, that exist in the San Juan River, if Morgan Lake becomes a source of introduction of these exotic species into the San Juan River. These include the Pacu, Plecostomus sp., gizzard shad, mosquito fish and common carp. It is suspected that gizzard shad have been introduced into the San Juan River by way of Morgan Lake and have made it down to Lake Powel. Also, it is likely that the San Juan River has been the source of introduction of the common carp into Morgan Lake.

The department has limited survey information for the lake, and is currently awaiting a report from the U.S. Fish and Wildlife Service from a survey that was conducted last November. We are also planning to do a follow up survey during March. Recent surveys have failed to identify any native fish species being present in the lake. Several other species have not been identified as still being present in the lake, although they had been introduced into the lake during the 1960's. These species include the threadfin shad, rainbow trout, fathead minnow, Tilapia, black bullheads and northern pike.

The Department recommends that Largemouth bass, channel catfish and green sunfish be the species that are investigated during the impingement study.

If you have any questions, please give ma a call at (928) 871-7068.

Sincerely,

Jeffrey Cole, Wildlife Manager
Department of Fish and Wildlife

CONCURRENCE

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Gloria M. Tom, Director
Department of Fish and Wildlife